

A TAXONOMIC STUDY OF THE GENUS *LAURENCIA* (CERAMIALES, RHODOPHYTA) FROM VIETNAM. III. *LAURENCIA CALLICLADA* SP. NOV.

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ABSTRACT — *Laurencia calliclada* Masuda sp. nov. (Ceramiales, Rhodophyta), described from Vietnam, is characterised by the following set of morphological features: 1) a basal system composed of a single disc from which a few, small, slender, softly fleshy, terete, upright axes develop; 2) the production of four periaxial cells from each axial cell; 3) the presence of longitudinally oriented secondary pit-connection between contiguous superficial cortical cells; 4) surface cortical cells that project in the upper portion of branches; 5) an absence of lenticular thickenings in the walls of medullary cells; and 6) a parallel arrangement of tetrasporangia. Furthermore, it produces a triterpenoid, callicladol, as a major halogenated secondary metabolite that is unknown in any other algal species.

RÉSUMÉ — *Laurencia calliclada* Masuda sp. nov. (Ceramiales, Rhodophyta), espèce décrite du Vietnam, est caractérisée par l'ensemble des particularités morphologiques suivantes: 1) un système basal composé d'un disque d'où se développent quelques petits axes dressés ténus, mollement charnus, de section arrondie; 2) la production de quatre cellules périaxiales à partir de chaque cellule axiale; 3) la présence de synapses secondaires orientées longitudinalement, entre les cellules corticales superficielles contiguës; 4) des cellules corticales faisant saillie à la surface des parties apicales des rameaux; 5) l'absence d'épaississements lenticulaires dans la paroi des cellules médullaires; et 6) une disposition parallèle des tétrasporocystes. En outre, cette espèce produit, comme principal métabolite secondaire halogéné, un tritérpenoïde, le callicladol, qui n'est présent dans aucune autre espèce d'algue. (Traduit par la Rédaction)

KEY WORDS: Ceramiales, chemotaxonomy, halogenated secondary metabolite, *Laurencia calliclada*, Rhodophyta, algae.

INTRODUCTION

Along Vietnamese coasts 21 species of the red algal genus *Laurencia* (Rhodomeleaceae, Ceramiales) have been reported (Dawson, 1954; Pham, 1969; Nguyen *et al.*, 1993; Masuda *et al.* 1997a, b, c, d). However, some species, which require further studies to confirm their status, may be included, as Cribb (1983) suggested that *L. paniculata* (C. Agardh) J. Agardh reported by Dawson (1954) is referable to *L. concreta* Cribb. This number is smaller than that of Chinese coasts where 30 species have been recorded (Zhang & Xia, 1988). It has been expected that more species would be found in Vietnamese waters. Our Vietnamese expedition during 1992 and 1993 reveals that many undescribed or unrecorded species of *Laurencia* are present (Suzuki *et al.*, 1995, 1996; Masuda *et al.*, unpublished observations).

It was reported in an earlier paper (Suzuki *et al.*, 1995) that a new triterpenoid, callicladol, had been extracted from an undescribed species, *Laurencia calliclada* Masuda sp. ined. The formal description of this species is now given.

MATERIALS AND METHODS

Specimens were collected on 8 February 1993 at An Thoi, Phu Quac Island, Kien Giang Province, Vietnam, and were fixed in 4% formalin in seawater. Some were dried as voucher herbarium specimens and deposited in the Herbarium of the Graduate School of Science, Hokkaido University (SAP 062092-062095). Sections were made by hand using a razor blade and pith stick. These were stained with 0.5% (w/v) cotton blue in a lactic acid/phenol/glycerol/water (1:1:1:1) solution and mounted in 50% glycerol-seawater on microscope slides.

OBSERVATIONS

Laurencia calliclada Masuda, sp. nov.

Plantae axibus rectis pluribus e disco basali communi effecti, flavida-rubra vel scarlatina, carnosa, mollis, exsiccatione chartae adhaerentes; thalli 2-4 cm alti, teretes, axibus principalibus percurrentibus; axes principales usque ad 1200 µm in diametro, ramos numerosos in modo irregulariter spirali ferentes; cellula axialis omnis cum cellulis periaxialibus quattuor; cellulae corticales superficiares etiam prope apices ramorum non procurrentes, cum foveis-colligationibus secundariis longitudinaliter dispositis inter se, in sectionibus transversalibus ramuli nec radiatim elongatae nec in vallem dispositae; incrassationes lenticulares in parietibus cellularum medullae absentes; tetrasporangia e cellulis periaxialibus in ramis ultimis et penultimis in successione acropetali formata, igitur in ordinatione parallela ad axem longitudinalem disposita; tetrasporangia matura 100-120 µm in diametro; cysto-

carpia laterales in ramis, ovoidea, 600-800 µm alta, 500-740 µm lata; spermatangia non inventa.

Plants with several upright axes arising from a common discoid holdfast, yellowish-red or scarlet, fleshy, soft, adhering to paper on drying; thalli 2-4 cm high, terete throughout, with percurrent main axes; main axes up to 1200 µm in diameter, bearing many branches in an irregularly spiral manner; each axial cell with four periaxial cells; superficial cortical cells projecting at the upper portion of branches, with longitudinally oriented secondary pit-connections between them, in transverse sections of branchlets neither elongated radially nor arranged as a palisade; lenticular thickenings absent in the walls of medullary cells; tetrasporangia formed from periaxial cells on ultimate and penultimate branches in acropetal succession, therefore arranged in parallel to the longitudinal axis; mature tetrasporangia 100-120 µm in diameter; cystocarps lateral on branches, ovoid, 600-800 µm high, 500-740 µm wide; spermatangia not found.

Holotype and type locality: SAP 062095 (tetrasporangial specimen, Fig. 1), collected at An Thoi, Phu Quac Island, Kien Giang Province, Vietnam (8.ii.1993) by M. Masuda.

Distribution: Endemic; known only from the type locality, facing the Gulf of Thailand, southern Vietnam.

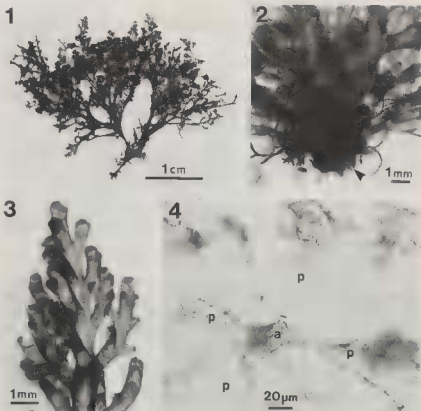
Etymology: The specific epithet is derived from two Greek compounds, *calli-* (beautiful) and *-cladus* (branch).

Plants grow on rocks or corallineaceous algae in the lower intertidal zone. Eight to twenty upright axes, including very small ones (detected under a dissecting microscope), arise from a common discoid holdfast 2.5-3.5 mm in diameter (Fig. 2) and have no creeping branches which function as secondary attachment organs; only one to four upright axes, however, fully mature. Thalli are 2-4 cm high, yellowish-red or scarlet, fleshy and soft, and adhere firmly to paper when dried. Main axes are percurrent and terete, 600-900 µm in diameter just above the basal disc, 800-1200 µm in the lower portion, then taper gradually to 500-700 µm distally.

Main axes bear many first-order branches in an irregularly spiral manner (Fig. 3) at intervals of 0.5-2.0 mm and at angles of 30-60°. First-order branches are 1.5-2.5 cm in length on lower to middle portions of the main axis and form progressively shorter branches of up to five orders. Branches of all orders show a polystichous arrangement. Adventitious branches are formed on main axes and lower portions of first-order branches.

The growing point is always sunk in an apical pit, as is typical of the genus. Axial cells are recognizable only near the apical cell, each producing four periaxial cells (Fig. 4). Superficial cortical cells of distal parts of branches of all orders are polygonal, 12-24 µm long by 16-32 µm wide (a length:width ratio of 0.5-1.0), and are regularly arranged in longitudinal rows in surface view. Superficial cortical cells of proximal parts of well-developed branches are 34-100 µm long by 26-50 µm wide (a length:width ratio of 1.0-3.3).

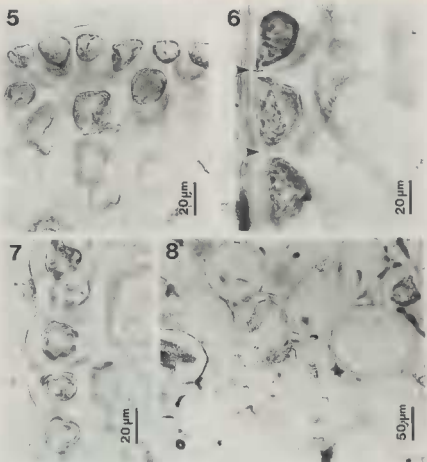
Superficial cortical cells in transverse section are 16-22 µm thick in upper portions of first-order branches and 36-60 µm thick in proximal portions. They are neither radially elongated nor form a palisade layer (Fig. 5). Longitudinally oriented secondary pit-connections are present between contiguous superficial cortical cells (Fig. 6). Superficial cortical cells project slightly in upper portions of branches (Fig. 7). Lenticular thickenings are not found in the walls of medullary cells (Fig. 8), which are up to 190 µm in diameter (walls being up to 2 µm thick) in lower portions of the first-order branches. As living material was not available, examination of *corps en cerise* was not performed.



Figs 1-4. *Laurencia colliculada*. Fig. 1. Holotype specimen (tetrasporangial) collected at An Thoi, Phu Quac Island, Kien Giang Province, Vietnam (SAP 062095). Fig. 2. The basal disc (arrowhead) and numerous upright axes. Fig. 3. Uppermost portion of a terete, radially branching axis. Fig. 4. Transverse section (TS) of the distal portion of a third-order branch showing an axial cell (a) with four periaxial cells (p).

Tetrasporangia are formed on ultimate and penultimate, ordinary (Fig. 9) and adventitious branches that are 900-2000 μm long by 500-600 μm wide. The tetrasporangial initial is cut off from an elongated periaxial cell towards the abaxial side (Fig. 10). In each fertile segment, only two of the four periaxial cells elongate (Fig. 11) and produce tetrasporangia. Each tetrasporangium is associated with two cover cells which are distally produced by the fertile periaxial cell (Fig. 12). Tetrasporangia mature acropetally, the young to almost mature sporangia showing a parallel arrangement along the longitudinal axis of the branch (Fig. 9). Mature tetrasporangia are 100-120 μm in diameter.

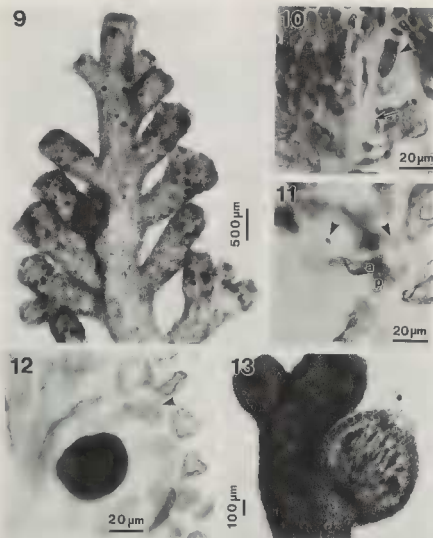
Cystocarps are borne laterally on branches of every order. Mature cystocarps are ovoid with a slightly beaked ostiole (Fig. 13) and 600-800 μm high by 500-740 μm wide. Spermatangia were not observed.



Figs 5-8. *Laurencia calliclada*. Fig. 5. TS of the distal portion of a third-order branch. Fig. 6. Longitudinal section (LS) of the lower portion of a first-order lateral showing longitudinally oriented secondary pit-connection (arrowheads) between contiguous superficial cortical cells. Fig. 7. LS of the distal portion of a third-order branch showing projecting superficial cortical cells. Fig. 8. TS of the lower portion of a first-order branch showing medullary cells lacking lenticular thickenings.

DISCUSSION

The following features have been used in combination to distinguish species in modern taxonomic treatments of the genus *Laurencia* (Saito, 1967, 1969; Saito & Womersley, 1974; Cribb, 1983; McDermid, 1988; Zhang & Xia, 1988; Nam & Saito, 1990, 1995; Vandermeulen *et al.*, 1990; Wynne & Ballantine, 1991; Gil-Rodriguez & Haroun, 1992;



Figs 9-13. *Laurencia calliclada*. Fig. 9. Upper portion of a second-order branch bearing tetrasporangial branchlets. Fig. 10. LS of a tetrasporangial branch showing a young tetrasporangium (arrowhead) borne on an elongated, fertile periaxial cell (arrow). Fig. 11. TS of a tetrasporangial branch showing an axial cell (a), one vegetative periaxial cell (p) (a second being out of focus) and two probable fertile periaxial cells (arrowheads). Fig. 12. LS of a tetrasporangial branch, a more developed tetrasporangium associated with one (arrowhead) of two cover cells. Fig. 13. Globular cystocarp with a slightly beaked ostiole.

Maggs & Hommersand, 1993; Masuda & Abe, 1993; Nam & Sohn, 1994; Ballantine & Aponte, 1995; Fujii & Cordeiro-Marino, 1996; Fujii *et al.*, 1996; Masuda *et al.*, 1996, 1997a, b, c, d); 1) the number (four or two) of vegetative periaxial cells per axial cell; 2) the basal attachment system whether consisting of a single primary discoid holdfast only, or a single primary discoid holdfast plus secondary holdfasts formed on prostrate, stolon-like branches, a prostrate primary axis, or descending lower branches; 3) the presence or absence of percurrent main axes; 4) the shape of main axes in transverse section, whether terete to subterete or compressed to flattened, and the dimension; 5) the branching pattern, whether spiral (the arrangement being either polystichous or tristichous), distichous, unilateral, verticillate or distichous-opposite; 6) the presence or absence of longitudinally oriented secondary pit-connection between contiguous superficial cortical cells; 7) the presence or absence of a surface-cortical palisade layer; 8) the presence or absence of projecting superficial cortical cells; 9) the presence or absence of lenticular thickenings in the walls of medullary cells; 10) the tetrasporangial arrangement relative to the longitudinal axis of the branchlet, whether parallel or perpendicular; 11) the presence or absence of additional tetrasporangium-bearing periaxial cells; 12) the position of tetrasporangium-bearing periaxial cells; 13) the shape of cystocarps; 14) the presence or absence of short papilliform branchlets; 15) the presence or absence of hamate (hooked) branches; 16) the presence or absence of deciduous branchlets that function as propagules; 17) the presence, absence and number per cell of *corps en cerise*; 18) the presence or absence of iridescence; 19) the dimensions of superficial cortical cells; 20) the dimension of medullary cells; 21) the presence or absence of intercellular spaces between outer cortical cells; and 22) the presence or absence of an outermost translucent layer. In addition, plant size, texture (whether soft or rigid, fleshy or cartilaginous) and colour have been used. Of these, the basal attachment system should be considered of primary importance because many investigators have described it, and it is known to be highly invariant (Saito, 1967; Cribb, 1983; Maggs & Hommersand, 1993; Masuda & Abe, 1993). Species with a basal system similar to *L. calliclada* are relatively few. Those species that require comparison with the alga under study are as follows.

Several Australian and Asian *Laurencia* species possess a primary discoid holdfast only. Of these, several also have longitudinally oriented secondary pit-connections between contiguous superficial cortical cells as in *L. calliclada*. Of these, five can be distinguished from *L. calliclada* by the absence of projecting superficial cortical cells: *L. clavata* Sonder (Saito & Womersley, 1974), *L. filiformis* (C. Agardh) Montagne (Saito & Womersley, 1974 as *L. filiformis* f. *filiformis*), *L. forsteri* (Mertens ex Turner) Greville (Saito & Womersley, 1974), *L. sphepherdii* Saito et Womersley (1974), and *L. tropica* Yamada (Masuda, unpublished observations). The presence or absence of projecting superficial cortical cells is an important specific feature (Yamada, 1931; Saito, 1969; Nam & Saito, 1990; Masuda & Abe, 1993). *Laurencia filiformis* and *L. forsteri* additionally differ from *L. calliclada* in having lenticular thickenings (Saito & Womersley, 1974). The taxonomic usefulness of lenticular thickenings has already been justified and discussed in detail (Masuda *et al.*, 1992, 1996, and references cited therein).

Laurencia silvae Zhang et Xia (1980, as *L. fasciculata* Zhang et Xia), described on the basis of material from the Xisha Islands, China, is similar to *L. calliclada* in the majority of its features. However, *L. silvae* has lenticular thickenings, plus dense clusters of branchlets in an abbreviated alternale arrangement (Zhang & Xia, 1980), unlike *L. calliclada*. Tetrasporangial branches of *L. silvae* are mostly 300–650 µm long, whereas those of *L. calliclada* are 900–2000 µm long.

Laurencia satoi Perestenko (1980), described on the basis of material from Peter

the Great Bay, Russia, and known from the western Pacific (Masuda & Abe, 1993), also shares many critical features including the absence of lenticular thickenings with *L. calliclada* (Masuda & Abe, 1993). The clearest difference between the two species is the number of upright axes that arise from a single holdfast, 20-250 upright axes in *L. saitoi* (Masuda & Abe, 1993) versus 8-20 in *L. calliclada*. Furthermore, *L. saitoi* has larger (up to 16 cm long), purplish-brown to dark purplish-red thalli and thicker main axes (up to 2.5 mm wide) (Saito, 1967, as *L. obtusa* (Hudson) Lamouroux; Masuda & Abe, 1993). These two species also produce quite different halogenated secondary metabolites, *L. calliclada* producing only the triterpenoid callicladol whereas *L. saitoi* produces many diterpenoids as major compounds (Takeda *et al.*, 1990, as *L. obtusa*; M. Suzuki, unpublished results) and several triterpenoids as minor ones (T. Suzuki *et al.*, 1985, 1987, as *L. obtusa*). The taxonomic importance of halogenated metabolites has been defended and discussed in detail by Masuda *et al.* (1996).

Laurencia saitoi is mainly distributed along warm temperate coasts in Japanese and adjacent waters (Masuda & Abe, 1993) and grows on both south — and north-facing rocks. It is also found in more southerly regions, including subtropical Okinawa Island, where it grows on rocks in low light conditions beneath overhangs in the upper intertidal zone (Masuda & Kamura, unpublished observations). By contrast, *L. calliclada* grows on south-facing rocks or coralline algae in the lower intertidal zone on tropical Phu Quac Island, the only locality in which it has been collected. These observations suggest that the two species have different ecological preferences.

A Hawaiian species, *L. crustiformans* McDermid, has longitudinally oriented secondary pit-connection between contiguous superficial cortical cells. However, it has a spreading basal disc and perpendicularly arranged tetrasporangia (McDermid, 1989), thus differing from *L. calliclada*.

Some Pacific American species with a single attachment disc deserve discussion. *Laurencia estebaniana* Setchell *et* Gardner and *L. subdisticha* Dawson, Neushul *et* Wildman differ from *L. calliclada* in having compressed axes (Setchell & Gardner, 1924; Dawson *et al.*, 1960). *Laurencia subcorymbosa* Dawson is distinguished from *L. calliclada* by the presence of lenticular thickenings and deciduous branchlets that function as propagules (Dawson, 1963).

Laurencia calliclada produces a characteristic triterpenoid, callicladol (Suzuki *et al.*, 1995). Many kinds of halogenated secondary metabolites have been reported from various species of *Laurencia*. These belong to four structural classes: sesquiterpenoid, diterpenoid, triterpenoid and C15 acetogenin (Erickson, 1983). Among halogenated triterpenoids, callicladol is unique in having a hydroxyl substituent at C-5 which has not yet been found in squalene-derived polyethers isolated from other species of *Laurencia* (Suzuki *et al.*, 1995, and references cited therein).

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BIBLIOGRAPHY

- BALLANTINE D.L. & APONTE N.E., 1995 — *Laurencia coelenterata* (Rhodomelaceae, Rhodophyta), a new diminutive species from the Dry Tortugas, Florida. *Botanica Marina* 38: 417-421.
- CRIBB A.B., 1983 — *Marine algae of the southern Great Barrier Reef. Part I. Rhodophyta*. Brisbane, Australian Coral Reef Society, Handbook No. 2, 173 p.
- DAWSON E.Y., 1954 — Marine plants in the vicinity of the Institut Océanographique de Nha Trang, Viet Nam. *Pacific Science* 8: 373-481.
- DAWSON E. Y., 1963 — Marine red algae of Pacific Mexico. Part 8. Ceramiales: Dasyaceae, Rhodomelaceae. *Nova Hedwigia* 6: 401-481.
- DAWSON E. Y., NEUSHUL M. & WILDMAN R., 1960 — New records of sublittoral marine plants from Pacific Baja California. *Pacific Naturalist* 1(19): 1-30.
- ERICKSON K.L., 1983 — Constituents of *Laurencia*. In: SCHEUER, P.J. (ed.), *Marine natural products*. 5. New York, Academic Press, pp. 131-257.
- FUJII M.T., COLLADO-VIDES, L. & CORDEIRO-MARINO M., 1996 — Morphological studies of *Laurencia gemmifera* and *Laurencia poiteau* (Rhodomelaceae, Rhodophyta) from the Nichupté Lagoon System, Quintana Roo, Mexico. *Botanica Marina* 39: 317-326.
- FUJII M.T. & CORDEIRO-MARINO M., 1996 — *Laurencia translucida* sp. nov. (Ceramiales, Rhodophyta) from Brazil. *Phycologia* 35: 542-549.
- GIL-RODRIGUEZ M.C. & HAROUN R., 1992 — *Laurencia viridis* sp. nov. (Ceramiales, Rhodomelaceae) from the Macaronesian Archipelagos. *Botanica Marina* 35: 227-237.
- MAGGS C.A. & HOMMERSAND M.H., 1993 — *Seaweeds of the British Isles. Vol. 1 Rhodophyta, Part 3A Ceramiales*. London, The Natural History Museum, 444 p.
- MASUDA M. & ABE T., 1993 — The occurrence of *Laurencia saitoi* Perestenko (*L. obtusa* auct. japon.) (Ceramiales, Rhodophyta) in Japan. *Japanese Journal of Phycology* 41: 7-18.
- MASUDA M., ABE T. & SAITO Y., 1992 — The conspecificity of *Laurencia yendo* Yamada and *L. nipponica* Yamada (Ceramiales, Rhodophyta). *Japanese Journal of Phycology* 40: 125-133.
- MASUDA M., ABE T., SUZUKI T. & SUZUKI M., 1996 — Morphological and chemotaxonomic studies on *Laurencia composita* and *L. okamurai* (Ceramiales, Rhodophyta). *Phycologia* 35: 550-562.
- MASUDA M., KAWAGUCHI S. & PHANG S.M., 1997a — Taxonomic notes on *Laurencia similis* and *L. papillosa* (Ceramiales, Rhodophyta) from the western Pacific. *Botanica Marina* 40: 229-239.
- MASUDA M., KAWAGUCHI S., TAKAHASHI Y., MATSUI Y. & SUZUKI M., 1997b — A taxonomic study of the genus *Laurencia* (Ceramiales, Rhodophyta) from Vietnam. I. *Laurencia caduciramulosa* sp. nov. *Cryptogamie, Algologie* 18 (1): 1-10.
- MASUDA M., TAKAHASHI Y., MATSUI Y. & SUZUKI M., 1997c — A taxonomic study of the genus *Laurencia* (Ceramiales, Rhodophyta) from Vietnam. II. *Laurencia lageniformis* sp. nov. *Cryptogamie, Algologie* 18 (2): 163-174.
- MASUDA M., TAKAHASHI Y., OKAMOTO K., MATSUI Y. & SUZUKI M., 1997d — Morphology and halogenated secondary metabolites of *Laurencia snackeyi* (Weber-van Bosse) stat. nov. (Ceramiales, Rhodophyta). *European Journal of Phycology* 32: (in press)
- McDERMID K.J., 1988 — *Laurencia* from the Hawaiian Islands: key, annotated list, and distribution of the species. In: Abbott I.A. (ed.), *Taxonomy of Economic Seaweeds with References to Some Pacific and Caribbean Species*. II, La Jolla, California Sea Grant College, University of California, pp. 231-247.
- McDERMID K.J., 1989 — *Laurencia crustiformans* sp. nov. (Ceramiales, Rhodophyta) from the Hawaiian Islands. *Phycologia* 28: 352-359.

- NAM K.W. & SAITO Y., 1990 — Morphology of *Laurencia cartilaginea* Yamada (Rhodomelaceae, Rhodophyta). *Bulletin of the Faculty of Fisheries, Hokkaido University* 41: 107-120.
- NAM K.W. & SAITO, Y. 1995 — Vegetative and reproductive anatomy of some *Laurencia* (Ceramiales, Rhodophyta) species with a description of *L. maris-rubri* sp. nov. from the Red Sea. *Phycologia* 34: 157-165.
- NAM K.W. & SOHN C.H., 1994 — *Laurencia kangjaewonii* sp. nov. (Ceramiales, Rhodophyta) from Korea. *Phycologia* 33: 397-403.
- NGUYEN H.D., HUYNH Q.D., TRAN N.B., & NGUYEN V.T., 1993 — *Marine algae of North Vietnam*. Ho Chi Minh, Nha Xuat Ban Khoa Hoc Va Ky Thuat, 364 p. (in Vietnamese).
- PERESTENKO, L.P., 1980 — Algae of Peter the Great Bay. Leningrad, Nauka, 232 p. (in Russian).
- PHAM H.H., 1969 — *Marine algae of South Vietnam*. Saigon, Trung-Tam Hoc-Lieu Xuat-Ban, 558 p. (in Vietnamese).
- SAITO Y., 1967 — Studies on Japanese species of *Laurencia*, with special reference to their comparative morphology. *Memoirs of the Faculty of Fisheries, Hokkaido University* 15: 1-81.
- SAITO Y., 1969 — The algal genus *Laurencia* from the Hawaiian Islands, the Philippine Islands and adjacent areas. *Pacific Science* 23: 148-160.
- SAITO Y. & WOMERSLEY H.B.S., 1974 — The southern Australian species of *Laurencia* (Ceramiales: Rhodophyta). *Australian Journal of Botany* 22: 815-874.
- SETCHELL W.A. & GARDNER N.L., 1924 — New marine algae from the Gulf of California. *Proceedings of the California Academy of Sciences, Fourth Series*, 12: 695-949.
- SUZUKI M., MATSUO Y., TAKAHASHI Y. & MASUDA M. 1995 — Callicladol, a novel cytotoxic bromotriterpene polyether from a Vietnamese species of the red algal genus *Laurencia*. *Chemistry Letters* 1995: 1045-1046.
- SUZUKI M., TAKAHASHI Y., MATSUO Y. & MASUDA M., 1996 — Pannosallene, a brominated C15 nonterpenoid from *Laurencia pannosa*. *Phytochemistry* 41: 1101-1103.
- SUZUKI T., SUZUKI M., FURUSAKI A., MATSUMOTO T., KUROSAWA E., KATO A. & IMANAKA Y., 1985 — Taurilene and thyriferyl 23-acetate, *meso* and remarkably cytotoxic compounds from the red marine alga *Laurencia obtusa* (Hudson) Lamouroux. *Tetrahedron Letters* 26: 1329-1332.
- SUZUKI T., TAKEDA S., SUZUKI M., KUROSAWA E., KATO A. & IMANAKA Y., 1987 — Cytotoxic squalene-derived polyethers from the red marine alga *Laurencia obtusa* (Hudson) Lamouroux. *Chemistry Letters* 1987: 361-364.
- TAKEDA S., KUROSAWA E., KOMIYAMA K. & SUZUKI T., 1990 — The structures of cytotoxic diterpenes containing bromine from the red marine alga *Laurencia obtusa* (Hudson) Lamouroux. *Bulletin of the Chemical Society of Japan* 63: 3066-3072.
- VANDERMEULEN H., GARBARY D.J. & GUIRY M.D., 1990 — *Laurencia minuta* sp. nov. (Ceramiales, Rhodomelaceae), a diminutive red alga from the Gulf of Aqaba (Red Sea). *British Phycological Journal* 25: 237-244.
- WYNNE M.J. & BALLANTINE D.L., 1991 — *Laurencia iridescens* sp. nov. (Rhodomelaceae, Ceramiales) from the Caribbean Sea. *Phycologia* 30: 394-401.
- YAMADA Y., 1931 — Notes on *Laurencia*, with special reference to the Japanese species. *University of California Publications in Botany* 16: 185-310.
- ZHANG JUNFU & XIA BANGMEI, 1980 — Two new species of *Laurencia* from Xisha Islands, Guangdong Province, China. *Oceanologia et Limnologia Sinica* 11: 267-274 (in Chinese).
- ZHANG JUNFU & XIA BANGMEI, 1988 — *Laurencia* from China: key, list and distribution of the species. In: Abbott I.A. (ed.), *Taxonomy of Economic Seaweeds with References to Some Pacific and Caribbean Species*. II, La Jolla, California Sea Grant College, University of California, pp. 249-252.